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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROJECT MERCURY (U)

STATUS REPORT NO. 9

FOR

PERIOD ENDING JANUARY 31, 1961

By Space Task Group, Langley Station, Va.

INTRODUCTION

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This report is the ninth in a series of reports on the status of the NASA manned-satellite project, PROJECT MERCURY. Earlier Status Reports covered the progress made through October 31, 1960.

The hardware construction and qualification phase of the project is proceeding and the flight-test phase is underway.

McDonnell Aircraft Corporation has delivered nine production capsules. Of these, five have been flown, and four are undergoing flight-test preparations at Cape Canaveral, Florida, and Wallops Island, Virginia.

Analysis of the in-flight failure of the first MERCURY-Atlas mission (MA-1) which occurred on July 29, 1960 has been essentially completed. Although no definite reason for the failure has been determined, structural modifications have been made in both the Atlas and the adapter to strengthen these items and special instrumentation has been installed in MA-2 and MA-3 to aid in diagnosis if the failure is repeated. MA-2 is now scheduled for February 21, 1961.

The first MERCURY-Redstone (MR-1A) was flown with complete success on December 19, 1960 following an unsuccessful launch attempt (MR-1) on November 21, 1960.

The second MERCURY-Redstone (MR-2) was flown on January 31, 1961. Although early burnout of the booster caused a high-altitude abort, many of the mission objectives were met and much valuable experience was gained.

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The first Little Joe flight of a production capsule occurred on November 8, 1960. The objectives of this flight test were not attained due to a premature firing of the escape rocket. The probable cause of the malfunction has been isolated and a repeat of this test is now scheduled for February 1961.

The MERCURY Astronaut training program has continued along the lines previously reported. Extensive use has been made of the McDonnell Procedures Trainers and of the Environmental Control System Trainer.

The installation of the tracking and ground instrumentation network is nearing completion. Construction has been completed at all stations. Equipment installation is essentially complete at all stations except Kano and Zanzibar. Equipment checkout and operator training is proceeding satisfactorily. The MERCURY Control Center at Cape Canaveral, Florida has been used in training simulations and in the MR-1A and MR-2 launches.

MANUFACTURING AND DELIVERY

The status of the manufacturing and delivery efforts on PROJECT MERCURY is discussed in the following paragraphs.

Capsule no. 2 (MR-1A) was successfully launched from Cape Canaveral, Florida, on December 19, 1960, and recovered the same day. The capsule was shipped to Langley Field, Virginia for review by NASA Space Task Group personnel on January 6, 1961. On January 19, 1961, capsule no. 2 was shipped to McDonnell for systems and component testing and postflight evaluation.

Capsule no. 3 (LJ-5) was launched from NASA Wallops Station on November 8, 1960, but due to a malfunction, the flight did not achieve the test mission. Since structural integrity is required prior to a manned orbital mission, capsule no. 14 (then unassigned) was assigned to the mission and numbered Little Joe No. 5A (LJ-5A). The hardware requirements of capsule no. 14 were changed to meet the requirements of the mission.

Capsule no. 5 (MR-2) was launched from Cape Canaveral, Florida on January 31, 1961 and was recovered the same day. It will be returned to Cape Canaveral and subjected to a postflight inspection, and will subsequently be sent to Langley Field for impact-bag deployment and flotation studies.

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Capsule no. 7 (MR-3) was delayed a month from the date published in the schedule (fig. 1) of Status Report No. 8. This delay was caused primarily by the necessity of rerunning the simulated mission test phase II and the correction of structural and equipment defects during the final preparation period. Capsule no. 7 was delivered to Cape Canaveral, Florida on December 8, 1960.

Capsule no. 8 (MA-3) was delivered, as scheduled in Status Report No. 8, to Cape Canaveral, Florida on November 18, 1960.

Capsule no. 14 (LJ-5A) was delivered to NASA Wallops Station on January 20, 1961.

Figure 1, PROJECT MERCURY Master Planning Schedule, shows the presently scheduled capsule delivery, prelaunch preparation time, and launch dates and sites.

MAJOR SYSTEMS

Capsule

The present status, schedules, and other plans for the various major systems of PROJECT MERCURY are given in the following sections:

Configuration and weight.- Capsule orbit weight and landing weight continue to grow slowly as a result of many minor changes and ballast requirements. Current orbit weight is 2,811 pounds, and reentry weight is 2,532 pounds. This steady weight growth has an adverse effect on the required boost and retrograde performances, and is decreasing structural margins during parachute deployment.

Flotation tests with pilot-egress capsule and boilerplate capsules indicate that the flotation stability is marginal.

Operational experiences with capsules at Cape Canaveral, Florida reveal many servicing difficulties. There will likely be some changes to improve access to components. The problem is to improve access without downgrading performance or delivery schedules.

Structure and heat shield.- Since Status Report No. 8, the capsule plus pylon structure has been statically tested for the maximum dynamic pressure, tumbling abort cases. It was demonstrated that the structure could withstand 130 percent of the design limit loads. This 30-percent margin of safety had been previously negotiated with Space Task Group and had been accepted.

In addition, the antenna fairing has been tested under drogue parachute loads. Failure occurred at 144 percent (150 percent required) design limit load in the center hold-down structure. This 6-percent deficiency in margin has been tentatively accepted pending a review of parachute loads and capsule weights.

The landing-bag strength problem mentioned in Status Report No. 8 has not been completely resolved. Modifications that were intended to improve the design of the reinforcing straps proved to be unsuccessful. As a result of the flight of MR-2, additional problems with the bag have come to light as follows:

(a) The protection of the capsule pressure bulkhead against impact by the edge of the heat shield was found to be inadequate to prevent puncture of the pressure vessel by some screws in the equipment attached to the bulkhead.

(b) It was further found that the straps and bag failed completely sometime between landing and recovery, causing complete loss of the heat shield.

Development tests at McDonnell and at Space Task Group are proceeding. In addition, revised landing-bag designs proposed by Space Task Group are being included in the McDonnell development tests.

A heat shield trimmed down to represent a shield in the ablated condition was successfully drop-tested on water using a boilerplate capsule. This test was performed with the heat shield fixed to the capsule (without a landing bag) at a horizontal speed of 42 feet per second and a vertical speed of 30 feet per second to demonstrate the capability of the shield to support the capsules with fixed heat shields (nos. 6 and 8). During the development testing of the straps, a similar heat shield broke during a test at a horizontal velocity of 63 feet per second. It is not known at this time if the heat-shield failure was a consequence of the strap failure. Investigation of this item is progressing.

As a result of heating tests at McDonnell, the cure cycle of the heat shields was changed to include a postcure at 350° F for 1 week. This postcure, however, has caused some excess porosity and some cracking or delaminating to occur. This problem is expected to be resolved by constructing the center shingle laminate of the heat shield (about 1 foot in diameter) separately and attaching it by means of adhesive and dowels after the postcure operation. In addition, a 0.2-inch thick layer of parallel laminate approximately 30 inches in diameter will be used to reinforce the inner face of the center area.

<u>Rockets and pyrotechnics</u>.- Following three posigrade-rocket qualification test failures during the last period, modifications were made to the motor design to eliminate the problems. The qualification

test program was repeated with all 36 motors being successfully fired.

The redesigned jettison-rocket igniters were successfully fired in the seven additional jettison-rocket qualification tests. These tests completed the qualification of the jettison rocket with straight nozzle. During qualification vibration testing of the triple-nozzle assembly, the shearpin designed to hold the assembly from rotating failed in all six assemblies. Atlantic Research Corporation has redesigned the locking mechanism and it is now being qualified.

The ignition system for the retrorocket has been changed from a throat-mounted pyrotechnic igniter to two case-mounted pyrogen igniters following an extensive evaluation of both systems. During the fourth qualification firing, the carbon insulator in the nozzle throat failed. This failure was traced to poor quality control of the carbon insert and has been corrected. A pyrogen igniter failed, due to overpressure in the twelfth qualification firing. However, the motor did ignite and burn for 11 seconds, at which time the nozzle expansion cone and pyrogen mount blew out. This malfunction was caused by a failure in the stainless-steel screen in the pyrogen igniter, allowing squib fragments to clog the pyrogen throat. This screen has been replaced with a perforated nickel disk. The redesigned pyrogen igniter will undergo extensive testing before continuing with qualification.

The gas-generator igniter for the parachute ejection bag was unable to pass the no-fire current test. McCormick Selph Associates, Inc. and Ordnance Associates, Inc. are both working on improved igniter designs.

Two qualification test failures of the explosive hatch with a single explosive cord have occurred. The hatch is now being redesigned to fail the bolts in tension rather than by stripping the threads. Tests with the modified bolts have been completed successfully.

Landing system (onboard).- All landing system components have been qualified with the exception of the ejector-bag gas-generator squibs (discussed under "Rockets and Pyrotechnics"). The main- and reserve-parachute suspension lines are being coated with polyvinyl chloride to protect them from possible exposure to hydrogen peroxide when the reaction-control fuel is jettisoned at main parachute deployment or should a leak occur.

The complete landing system was installed in the MR-1A and MR-2 capsules and apparently performed as planned.

Environmental Control System.- The current status of the Environmental Control System (ECS) is as follows:

(a) The qualification and reliability test programs being conducted by the AiResearch Manufacturing Division, Garrett Corporation are essentially complete. The new model cabin-pressure relief valve (5-psi differential pressure) must undergo the complete qualification test program; eight other components are undergoing humidity tests at the present time with completion of tests expected by early February 1961.

(b) The oxygen pressure switch failed during the qualification test program and will be replaced with two thermistors, one at the discharge of each oxygen bottle-reducer assembly. An interruption of flow from the supply will illuminate a warning light on the instrument panel. A switch is to be provided so that the astronaut can select either sensing device.

(c) System assemblies through capsule no. 15 have been completed, and assemblies for capsules nos. 16 through 18 are presently in process.

Pressure suits.- The MERCURY Astronauts have used their flight-type suits extensively in the Procedures Trainer and the ECS training program. Since delivery in September 1960, each suit has undergone a series of adjustments and minor modifications to maximize comfort and proper fit. With these alterations completed, the manufacturer started production of a duplicate suit for each Astronaut in December 1960. The duplicate suits, which are to serve as backups during flight operations, will be delivered in early February 1961.

The new bioinstrumentation connectors installed in the suits have proven highly satisfactory during centrifuge and ECS training. The connector, which is a special adaptation of a proven Bendix connector, has solved the problem of unsatisfactory bioinstrumentation read-outs caused by the old, snap-type connector.

The U.S. Navy Parachute Facility at El Centro, California has completed qualification of the personal parachute planned for Redstone flights. The Redstone survival pack has been split so that the raft portion may be attached to the personal parachute before bailout. Navy representatives visited Space Task Group during January 1961 and completed fitting and fabrication of the Astronauts' flight-type parachute harnesses.

Attitude control systems.- The Attitude Stabilization and Control System (ASCS) and the Rate Stabilization and Control System (RSCS) are now fully qualified with the addition of an audiofilter to the RSCS damper. The RSCS damper, until the incorporation of the special filter, was susceptible to 400-cycle ripple. The unit incorporating this filter has passed qualification pending actual receipt by McDonnell of the Minneapolis-Honeywell Regulator Company document which is in the process of transmittal.

The decision has now been made to change from an orbit attitude of 14.5° to 34°. Consequently the improved type A-8 amplifier-calibrator which incorporates the ability to preselect orbit attitude is being fitted in capsules nos. 9 and up. This amplifier-calibrator also includes minor improvements to the yaw-slaving circuits and protection of relay-driving transistors against negative-voltage transients. No further transistor failures have occurred since the provision of regulating diodes to the amplifier-calibrator power supplies.

The horizon scanners have been retrofitted with improved drive components to eliminate starting failures. A unit on bench test has run 500 hours before failure of a motor bearing occurred. The manufacturers have improved the quality control in this area.

Qualification of the periscope has still not been accepted by McDonnell because of retracting-mechanism problems. Improved motors, limit switches, and roller bearings are being evaluated with a view to completing qualification by February 15, 1961.

Results of the MR-1A and MR-2 flight tests show that the ASCS behaved as predicted during all phases of the mission.

<u>Reaction Control System</u>.- Bell Aerosystems Company has completed 70 missions in the reliability program for the automatic subsystem and 55 missions for the manual subsystem. The McDonnell anodized 52-SO tubing initially installed in the manual subsystems had been essentially replaced in order to make the system tight. The six manual subsystem qualification missions have been postponed until the seventy-sixth mission due to difficulties experienced in the program with the throttle valves.

All components have been qualified with the exception of the explosively-actuated valves. In this case, there is a difference of opinion on the testing technique used by Bell.

The anodizing of the 52-SO tubing for capsules nos. 9 and up has been abandoned due to the inability to seal at the joints. Instead, the 52-SO tubing is now passivated. Problems still exist with this tubing; however, poor quality of both the Voi-shan washers (which are still required to some extent) and flare nuts has contributed to these problems.

A problem has arisen due to corroded solenoid valves. An investigation has shown that these valves are not adequately dried prior to shipment at Bell and that the plating quality used is not adequate for long-term storage under moist conditions. Bell is now disassembling and drying these valves before shipping. Meanwhile, McDonnell is investigating the possibility of a more adequate system purge with a lower vacuum technique.

The throttle valves have been binding after a short time of use in the system. This condition is apparently caused by minute particles of foreign material lodged between the sliding surfaces. Bell and the National Waterlift Company, Division of Cleveland Pneumatic Industries, Inc. are reviewing the design and quality-control procedures to minimize possible internally-caused particles. McDonnell has changed the system-flushing procedures to eliminate flushing through these valves. The manual subsystem qualification has been postponed pending the resolution of this problem as noted previously.

The H_2O_2 tank transfer tube is being redesigned as a result of several tubes being crushed when the bladder was inadvertently collapsed with full operating pressure.

The first capsule with an active Reaction Control System (MR-1A) was launched during this period. One problem which arose during this launch effort was helium relief-valve leakage; this was an obsolete unqualified valve and has been replaced on subsequent capsules.

Pilot support system.- Drop tests of the couch and its supporting structure to determine landing loads, without the impact bag extended, have been completed. A maximum load of 96g was imposed on the reaction block that simulates the heat shield of the capsule. This value corresponds to 125 percent of the maximum load measured during full-scale drops of boilerplate capsules. The couch was loaded with an instrumented anthropomorphic dummy, held in place by a standard MERCURY harness. The test couch had been dropped 12 times during the program, including one drop each in the head-down, feet-down and left-side-down attitudes. These attitudes encompass the various possible attitudes of the capsule during landings. The impact velocity was 30 feet per second.

As a result of the test series it is apparent that:

(a) The couch structure will not be damaged by impacts of 30 feet per second in the expected attitudes.

(b) The crushable aluminum honeycomb will attenuate a vertical impact of 30 feet per second to levels such that the occupant will not be injured but may be momentarily dazed.

(c) If an escape from the launch pad is necessary, if the landing bag does not deploy, and if the capsule then strikes the ground at an angle of about 28° with the vertical, then injury can be expected.

The extent of the injury cannot be predicted and would vary with the angle of impact, wind velocity, and landing-surface variables such as hardness, angle and ground cover. The feet-down attitude appears to be the most hazardous. In this landing position, back and abdominal injuries are quite probable. The head-down impact attitude appears to be less hazardous unless the capsule is crushed in far enough to strike the occupant's head.

One set of flight couches has been shipped to Cape Canaveral. The second set, now at Langley Field, will be returned to McDonnell for refinishing and then shipped to Cape Canaveral. Final modifications have been agreed upon for the restraint harness, and the design has been released for manufacture of all capsules.

Crew station layout, controls, and displays.- The requested improvements noted in the Development Engineering Inspection (DEI) were rechecked on followup visits on capsule no. 7 and rechecked at the second inspection on later capsules. The improvements requested are being complied with.

The planned tests on the vision through the astronaut window and on panel reading under capsule illumination were conducted with the following results:

(a) With any amount of white light illumination within the capsule, no stars are visible if the polarized filter is in place. Without the polarized filter, stars up to fourth magnitude are visible if no more than $\frac{1}{8}$ inch of white light is used on each of the cabin flood lights.

(b) With full red light and the filter in place, third magnitude stars are visible. With full red light and without the polarized filter in place, fourth to fifth magnitude stars are visible.

(c) Two observers with previous flying experience adjusted the opaque filter to where $\frac{1}{2}$ inch to $1\frac{1}{2}$ inches of red light was available from each of the capsule floodlights. Under this condition the needles of the panel instruments are visible, although the numerical markings are not. (The blue roll-attitude and roll-rate needles are not visible under these conditions.) Under this optimal lighting condition for nighttime, fourth to fifth magnitude stars are visible with the polarizing filter in place. Without this filter, fifth to sixth magnitude stars are visible. Thus, under optimal internal lighting conditions, visibility through the window is a close approximation of direct vision outside the capsule.

(d) No multiple images of the stars were observed either with or without the polarizing filter.

(e) The horizon, under nighttime conditions, was simulated with a piece of black paper held 2 inches to 3 inches above the window. This simulated horizon was easily visible under the optimal lighting conditions, and pitch and roll attitudes could be readily determined.

(f) The amber warning lights, when set to the dim condition, interfered with vision in the area of their reflection but did not affect star visibility in other areas. The green sequence lights produced a marked reduction in the visibility of stars in all areas.

(g) Window scribe lines were not visible under the low levels of illumination which were required in order to see the stars through the window. Part of this effect was due to the tendency of the eyes to focus at infinity in order to view the stars.

(h) The pressure-suit visor produced no decrease in visibility of the stars as long as no warning or sequence lights were illuminated. With either warning or sequence lights, the reflection in the visor produced reduction in the visibility of stars.

(i) Little or no reduction in visibility of stars was noted, due to the viewing angle through the window. Looking through the lower part of the window produced essentially as good star visibility as viewing through the upper part of the window.

(j) Looking through the upper part of the window, as is necessary in order to see any stars when the capsule is in the retrograde attitude, was uncomfortable if required for any extended period of time.

(k) The stars are bright enough so that they fall in the upper end of the dark adaptation curve, and therefore, sufficient adaptation takes place in a very short time to permit the viewing of third and fourth magnitude stars. One observer was able to see third magnitude stars immediately after 1-minute exposure to a 28-volt spotlight illumination level. Within a minute, both subjects were able to see at least fourth magnitude stars.

Communications (onboard).- The status of onboard communications equipment is as follows:

HF voice transmitter/receiver - Thirty-one of 32 units for the orbital capsules have been delivered. Delivery is expected to be completed by April 30, 1961. All 24 rescue units have been delivered. Design approval and reliability tests have been completed, and test reports are expected by February 1, 1961.

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UHF voice transmitter/receiver - Forty-eight of 51 units have been delivered. Two of the remaining units are expected to be delivered by February 15, 1961, and the third by April 30, 1961. Design approval and reliability tests have been completed, and test reports are expected by February 1, 1961.

Audio center - Thirty-three of 35 units have been delivered, and delivery is expected to be completed by March 30, 1961. Design approval and reliability tests have been completed, and test reports are expected by February 1, 1961. Some problems have been encountered due to inadvertent VOX keying. Vibration has been discounted as the cause, and an investigation is now being made into the affect of B+ voltage fluctuations (due to earth-and-sky camera frame stepping) on the VOX.

Command receiving and decoding system - Forty of 55 units have been delivered, and delivery of the remaining units is expected by March 7, 1961. Design approval and reliability tests have been completed, and test reports are expected by March 15, 1961. Arrangements have been made to have further RF interference tests made on this system at White Sands Missile Range Proving Ground.

Radar beacons - Twenty-eight of 33 S-band beacons and 27 of 33 C-band beacons have been delivered. Delivery of three of the remaining S-band beacons and four of the remaining C-band beacons is expected by February 28, 1961. The remaining two units of each type of beacon are scheduled for delivery by April 1, 1961. Design approval and reliability tests have been completed, and test reports are expected by March 8, 1961. Double-pulse S-band beacons will be installed in capsules nos. 7, 8, 9, 12, and up; double-pulse C-band beacons will be installed in capsules nos. 9, 12, and up.

HF/UHF rescue beacon - All 29 units have been delivered. Design approval and reliability tests have been completed, and test reports are expected by March 1, 1961.

Control panel - All 31 units have been delivered. Design approval and reliability tests have been completed, and test reports are expected by February 1, 1961.

Auxiliary rescue beacon - All 11 units have been delivered. Design approval and reliability tests have been completed, and test reports are expected by February 1, 1961.

Telemetry transmitters, power supplies and line filters - Fifty-seven of 76 transmitters and power supplies have been delivered. Delivery was delayed due to difficulties encountered with noise during vibration and a change in deviation sensitivity with temperature.

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McDonnell now believes that these problems have been overcome, and delivery has resumed at the rate of approximately three units per week. Completion of delivery is expected by March 15, 1961. The original order of 30 line filters has been delivered, and an additional order has been placed for more units for use as spare parts. Design approval tests have been completed on the telemetry system, but the 1,000-hour reliability test is still being conducted. The design approval test report is expected by February 23, 1961.

Multiplexer - All 24 units have been delivered. Design approval and reliability tests have been completed, and test reports are expected by February 15, 1961.

UHF power amplifier - Twenty-five of 26 units have been delivered. Delivery of the remaining unit is expected by April 30, 1961. Design approval and reliability tests have been completed, and test reports are expected by February 7, 1961.

Discone antenna - Seventeen of 22 units have thus far been fabricated by McDonnell.

Discone isolator - All 26 units have been delivered. Design approval and reliability tests have been completed, and test reports are expected by February 1, 1961.

C- and S- band antenna and power divider - Twenty-three of 24 units have been delivered, and delivery is expected to be completed by February 5, 1961. Design approval and reliability tests have been completed, and test reports are expected by March 16, 1961.

UHF rescue antenna - All 26 units have been delivered. Design approval and reliability tests have been completed, and test reports are expected by February 1, 1961.

HF rescue antenna and impedance match - Environmental qualification of the $16\frac{1}{2}$-foot whip antenna has been completed. The explosive cartridge which causes this antenna to extend has not yet been qualified due to the fact that only 60 percent of the antennas tested have extended to design length. This problem is being worked on. All 21 impedance-matching networks have been delivered. This network has passed both the design approval and reliability tests, and test reports are expected by February 1, 1961.

Coaxial switches - Forty-five of 46 units have been delivered. Expected delivery date of the remaining unit is March 15, 1961. Design approval and reliability tests have been completed, and test reports are expected by February 1, 1961.

HF diplexer - All 23 units have been delivered. Design approval and reliability tests have been completed, and test reports are expected by February 1, 1961.

MR-1A Mission - Continuous telemetry was received from lift-off until 20 seconds prior to splash. Transmission quality was good, the agreement of telemetry data with data recorded by the onboard tape recorder was within approximately 2 percent. The effects of booster ionization and tower separation on telemetry transmission were determined. C- and S- band radars tracked the vehicle from lift-off to 2 minutes and 28 seconds prior to splash. Radar signal strengths were plotted against capsule events, and signal dropouts were located (for each individual radar). From these charts, a comprehensive chart showing areas of acquisition was evolved.

Instrumentation.-

(a) The recent firings of LJ-5 and MR-1A have given the instrumentation system the first real test under flight conditions. Although these flights were of comparatively short duration, they have proved that the system can operate successfully under these environmental conditions since good data were acquired in both cases.

(b) Since the removal of both the original O_2 and CO_2 partial-pressure transducers from the standard system due to the inherent weaknesses of these transducers, there has been introduced a new type of O_2 partial-pressure device. This device is much improved over the previous device, having better stability and longer shelf life. The new transducer will now be fitted into the suit circuit at the point previously occupied by the CO_2 transducer. Effectivity of this change will be capsules nos. 12, 15, and up. The range of the transducer will be 0 to 6 psi. A reliable substitute for the original CO_2 transducer has yet to be found.

(c) A new respiration sensor for the primate is now being tested. This sensor is a stretch-belt type, the sensing element being a rubber tube filled with copper-sulphate solution which varies its resistance with expansion and contraction. The element is fed to a three-stage amplifier, which in turn feeds the voltage-controlled oscillator (VCO). The device is first being introduced on capsule no. 5 after testing at Holloman Air Force Base, Alamogordo, New Mexico.

(d) Both the noise and vibration analyzers are being removed from the standard instrumentation of all capsules except no. 5. The reasons for this are:

(1) The commutation of the signals make the deciphering of the intelligence very difficult.

(2) The slow scan time (10 seconds) causes the bulk of the information to be missed in the spectrum while one small part is being analyzed.

(3) The wide bandwidths of the scanners cause problems in determining the precise frequency analysis of the signals.

(e) As mentioned in Status Report No. 8, the onboard programer has had the camera sections redesigned into solid-state circuitry to obviate the generation of interference. Preliminary bench testing of this modification reveals a marked reduction in interference, although the interference level has not yet come down below the military specification values.

(f) In order to assist the ground stations in determining more easily the occurrence of sequence signals, a separate regulated 3-volt power supply has been introduced to feed the majority of the telemetry sequence circuits. Previously these were fed from one of the isolated busses which were subject to some voltage fluctuation, hence causing slightly different signal levels in the ON conditions. This new regulated supply is independent of the main 3-volt instrument supply.

(g) Due to the high failure rate of the outer skin temperature probes on the standard system, a new mounting method has been developed. The leads were previously overstressed at the junction of the probe, and consequently, breakages were frequent. In the new method, the transducer is cemented to a thin plate which in turn is welded to the skin. The leads are secured better and the resulting unit has much higher physical strength and consequently less possibility of damage.

Satellite clock - The Waltham Precision Instrument Company clock contract was cancelled December 14, 1960. Waltham was still faced with major difficulties with little or no assurance of solution in time for any of the MERCURY flight program.

The first of the McDonnell orbital timing devices was completed approximately December 1, 1960 and went into the Qualification Test Program. Unit no. 2 has gone into capsule no. 10 for its test program, no. 3 into capsule no. 9, and no. 4 into the Qualification Test Program. Compatibility tests were made between the McDonnell clock and the Wallops Ground Range Station using the DC-4 airplane. The results of these tests were, in general, quite satisfactory, and it is believed that no major compatibility problem exists. Some problems still exist in passing the full environmental test program, but these problems appear to be in the process of solution.

Power supplies.-

Batteries - All planned testing and test reports have been submitted and approved.

Inverters - 250VA - Three of 4 have completed 1,000-hour life tests. The fourth will be completed in February 1961.

100VA - Two of 4 have completed 1,000-hour life tests. Unit three will be complete on February 15, 1961. Unit four will be complete on March 1, 1961.

All inverter testing and test reports will be submitted by March 15, 1961.

Boosters

Atlas performance.- Within the past 3 months, new estimates of the performance for MERCURY-Atlas missions have been made. Several factors have adversely affected performance. Recently, Rocketdyne Division of North American Aviation, Inc. discovered a discrepancy in the calculated Atlas thrust which results in lower calculated performance. In addition, the steadily increasing capsule weight and the possibility of a higher weight for the Atlas vehicles have been considered.

Because of these factors, it is planned to change the orbit from 93.2-nautical-mile perigee to another which will be more satisfactory. The selection of the orbital conditions is a compromise among:

(a) Atlas velocity potential

(b) Atlas guidance accuracy

(c) The ability to restrict the landing area to the Atlantic Ocean for aborts near insertion.

At the present time, it is believed that the orbital insertion altitude will be about 89 nautical miles. This will result in a probability of a successful insertion above 99 percent with good guidance accuracy and a high probability of avoiding Africa for aborts from near insertion.

MERCURY-Atlas structure.- The similarity of the Atlas-Able V-B failure to the MA-1 failure has led to a renewed effort to explain the MA-1 incident. Data from these flights indicated that the mode of failure was a structural rupture in the area of the adapter or upper LOX tank.

The adapter mounted on a stub LOX tank was successfully static-tested to 150 percent of design limit load.

Vibration testing of the adapter has revealed the existence of two very lightly damped modes. The fluctuating pressures measured in the wind-tunnel tests at the Air Force Arnold Engineering Development Center (AEDC), Tullahoma, Alabama can excite these modes. Present estimates indicate that the amplitude response would be insufficient to harm the adapter. However, the intermediate rings of the adapter have been stiffened for future flights. Vibration tests of the stiffened adapter have shown that its amplitude response to random pressure fluctuations has been reduced by an order of magnitude. Exact calculations of the effect of the aerodynamic buffeting on the response are beyond the state of the art. Added strain-gage instrumentation on the MA-2 vehicle will indirectly indicate the existence of this effect.

In addition, a review of applied loads, internal load distribution, and detail stressing of the adapter and upper LOX tank has been carried out.

The loads review showed that the static loads were predictable and well-defined. Dynamic loads are much harder to predict and must be done on a probability basis. Gust and buffet bending moments have been evaluated in a conservative fashion. Gust criteria are still controversial in that fine-grain gusts are not considered. However, data from MA-1 indicate that there was only negligible response to this type of forcing. Also, buffet axial loads have not been considered. Estimates of these loads show them to be small but not negligible. Here again, the added strain-gage instrumentation on MA-2 will measure these loads.

A survey of the internal load distribution in the adapter and upper LOX tank revealed two sources from which the internal axial loading could depart from the ideal uniform loading. The first of these is the presence of heavier-than-average longitudinal stiffeners on the adapter at the stretch fittings and boiloff valve opening. The concentrations of material will cause the load being transmitted to the Atlas to concentrate at these points. The static test of the adapter with stub tank has shown that this effect is not harmful in itself. The second of these is the presence of the lightly-damped modes in the MA-1 adapter. Response of these modes to fluctuating pressures will cause the internal axial loading to peak at nodal lines. However, an analysis of this has shown that, even though this effect is not small, it is not sufficient to buckle the adapter or upper LOX tank skin. The stiffening of the adapter rings will minimize this effect, and the added instrumentation for MA-2 will indicate the effectiveness of this stiffening.

[redacted]

A review of the detail design and stressing of the adapter has shown the adapter to be sound. A similar review of the Atlas upper LOX tank has revealed the existence of sizable discontinuity stresses and unfavorable peeling moments at the welded joint immediately below the adapter-Atlas interface ring. These stresses can be increased by twisting of the interface ring introduced by the adapter breathing. These detrimental stresses and moments will be greatly reduced by using thicker skins in that region of the LOX tank and by using the stiffened adapter. For the MA-2 flight, an interim modification will be used in addition to the stiffened adapter. This modification consists of an 8-inch band of stainless steel (same material as the LOX tank skin) snugly fitted to the outside of the LOX tank just below the interface station. The purpose of this band is to reduce the present discontinuity and hence reduce the associated stresses and peeling moments. In effect, it moves the discontinuity towards the center of the skin panel and away from the welded joint. It reduces the hoop-tension stresses due to internal pressure in this region, and consequently, enhances the tear resistance.

The exact reason for the failure of MA-1 has still not been definitely established. The effects mentioned above are all contributors to an objectionable situation. It is felt that the stiffening of the adapter rings and the interim modification to the upper LOX tank have eliminated all known adverse effects for MA-2. The added instrumentation on this flight will be extremely helpful in further understanding the loads and structural behavior in this area, and should result in a substantial increase in confidence level.

Atlas abort-sensing.- The flight tests of the Atlas abort-sensing system have been successfully completed. MA-2 is to be flown with the system closed-loop.

The only system change incorporated since Status Report No. 8 is to decrease the differential pressure abort threshold from 4 ± 0.5 to 2.5 ± 0.5 psi and to install an orifice in the LOX sensing line to minimize apparent LOX pressure fluctuations. This change is limited to MA-2 at present, where the pressures before and after the orifice will be measured. After reviewing the flight data, a decision will be made relative to the remaining flights.

The life tests or reliability demonstration tests on the component level are still underway; the tests on the pressure switches are approximately 35 percent completed.

The reliability testing on the abort canisters (system tests) are to start during February 1961 at Universal Test Laboratory, and the search for critical weakness tests on the abort canister are approximately 35 percent completed.

[redacted]

Redstone abort-sensing.- NASA Marshall Space Flight Center (MSFC) has completed all reliability tests on the individual components. Reports have been received on all components except the combined report on the rate switches which is now being written. The Chrysler Corporation reliability tests of the MR-1 aft section have been completed, including the random vibration and humidity tests. The reports on these tests have been written and are being reviewed by MSFC prior to copies being transmitted to Space Task Group.

MR-1A was flown with the abort-sensing system open-loop, and the system performed satisfactorily. MR-2 was flown closed-loop, and the abort-sensing system performed its functions satisfactorily; it aborted the capsule when early fuel depletion caused low-chamber pressure just prior to the planned deactivation of that part of the abort-sensing system. Although the abort was unscheduled, the abort-sensing system operated properly.

Crew Training

Environmental Control System Trainer.- During this quarter, several of the Astronauts participated in the ECS training program at the Navy Air Crew Equipment Laboratory (ACEL), Philadelphia, Pennsylvania. The purpose of this program was to familiarize the Astronauts with the ECS, and to expose the Astronauts to a simulated Atlas three-orbit mission with a reentry heat pulse and approximately $1\frac{1}{2}$ hours of post-impact temperatures similar to those expected for an Atlas profile. Physiological and psychological data, to check for possible stress or fatigue, were taken throughout the mission. Astronaut familiarization with the ECS controls, instruments, and effects thereof was accomplished during this program.

Flight monitoring.- Two of the Astronauts visited the Flight Control Center in Bermuda in the past quarter in order to continue their training in support of the flight control function. Also, during the MR-1 countdown and launch, Astronauts were posted within the blockhouse and MERCURY Control Center for the same purpose.

Weightless flying.- Some of the Astronauts experienced weightlessness with limited visual orientation at Langley Field on January 9 to 10, 1961. This program was supported by Air Force Wright Air Development Division (WADD) personnel using the C-131 modified for flying weightless trajectories. Little effect was discerned from this limitation on visual orientation.

System study.- In January 1961, personnel from the Space Task Group Operations Division gave lectures to the Astronauts on capsule systems with free discussion throughout the class periods.

Procedures Trainer No. 1.- The trainer continues to be used almost daily by the Astronauts with emphasis on Redstone flights. For many training sessions, the Astronauts have worn pressure suits. A modification to the trainer has provided the ability to give the Astronaut a sequence of retrofires to permit repetitive drills in manual control of capsule attitude. Recordings of capsule motion and hand-controller motion have been made during these sessions and are being analyzed by the Space Task Group Training Office.

A simple simulation of a stationary star field has been added to provide further experience in adjusting interior light level and color. Other modifications to the trainer continue to be made to reflect changes in the specification capsule.

Procedures Trainer No. 2.- This trainer, to date, has been used almost exclusively as a generator of simulated capsule telemetry data for MERCURY Control Center crew training exercises and for the preparation of magnetic tape recordings to be used for Remote Station crew and equipment checkout exercises. From early February 1961, however, it is expected that the trainer will be in use for Astronaut training much of the time.

Centrifuge Program No. IV.- The fourth acceleration training program on the Navy Aviation Medical Acceleration Laboratory (AMAL) at Johnsville, Pennsylvania, is scheduled for the period of May 29 to June 30, 1961. The primary purpose of this program is to thoroughly familiarize the Astronauts with the acceleration trajectories associated with the normal MERCURY-Atlas mission and to give the Astronauts additional training in the retrofire-control task, the orbital-attitude-control task, and the reentry rate-damping task.

Air-Bearing Orbital Trainer.- Installation of the simulated earth horizon for the $14\frac{1}{2}^{\circ}$ nose-down capsule attitude has been completed. A simulated earth horizon and a star display for the 34° nose-down retro-attitude have been designed and are now under construction. The emphasis in the training program has been on the control of simulated retro-rocket disturbance torques using the periscope and the one available simulated horizon as references.

Attitude-and-Rate Display Trainer.- A gimbal-mounted half-scale transparent capsule containing the MERCURY capsule attitude-and-rate indicating system has been developed and fabricated. The purpose of this trainer is to familiarize the Astronauts with the behavior of the attitude gyros when the capsule is maneuvered and to learn how to restore the attitude indicators to their correct readings after a tumbling maneuver.

Emergency exit training.- A program is planned for the month of February 1961 to develop techniques and procedures for utilizing the personal parachute for airborne emergency exit.

Animal Program

Training of the primates for the advanced psychomotor problem for the Atlas flights is continuing. One aspect of this training is conditioning to ignore a distracting environment. Noise and vibration training is in progress at the Air Force Missile Development Center (AFMDC), Holloman Air Force Base, New Mexico. It will, as on previous occasions, be combined with acceleration stress at the Air Force Aerospace Medical Laboratory (WADD), Dayton, Ohio in repeated runs during February, March, and April 1961. The medical van and a caging and training van will be required at WADD for these tests. Conditioning to brief zero-gravity flights in a KC-135 aircraft at AFMDC is planned together with simulation of launch curves on the captive missile track. Motion-sickness susceptibility is being reviewed and, if it is important, will be a selection criterion.

Three flight couches for the MR-2 flight were delivered and checked out at Hangar S, Cape Canaveral, Florida. They held pressure and performed satisfactorily. Pellet feeders, water feeders, and advanced psychomotor testers are all completed. Flight couches equipped with these items will be delivered in the near future and will receive final operational checks at AFMDC animal facility during the next few weeks. Quality control tests on this equipment are underway at McDonnell Aircraft Corporation.

Biosensors.- The electrocardiograph amplifiers have shown interference during psychomotor response and direct-current level shifts under flight configuration. The problem has been solved by amplifier redesign and electrode alterations. A troublesome oscillation of the respiratory sensor has been resolved and biosensor records appear satisfactory in flight configuration.

Animal performance.- The performance of the animals and the functioning of the psychomotor equipment has proved satisfactory in flight configuration. Switches of improved reliability have been installed in the couches.

Animal complex.- The entire van complex, including the transfer trailer, has been in continuous use supporting the Aeromedical Group for the MR-2 operation for over 4 weeks. A number of maintenance and procurement problems were worked out in cooperation with the staff of Hangar S, and the routines of operating and servicing the vans, including the transfer van, have been established.

MR-2 flight.- Preparations for the MR-2 flight progressed satisfactorily, and operational plans for prelaunch activities were repeatedly tested out, with a smooth working procedure for the countdown being evolved. In the flight which occurred on January 31, 1961, both the chimpanzee and the biomedical equipment appeared to operate in a completely satisfactory manner.

QUALIFICATION PROGRAM

The qualification program for PROJECT MERCURY is so planned that as many hardware items as possible will be exposed to, and their operation proven in, those environments to which they will be subject in both normal and emergency conditions for orbital flights. The following sections discuss the ground-test portion of this qualification program. The flight-test program is discussed in a separate section of this report.

McDonnell Qualification Program

The testing status of most of the primary systems is listed in the discussion of each system in the section entitled "Major Systems." The status of other items is listed in the following paragraphs.

(a) Satellite clock - The first qualification test clock built by McDonnell is in fabrication, and tests were started in January 1961. Procurement of the Waltham clock has been cancelled.

(b) Explosive egress hatch - Following incipient failures of hatch separation with a 9 gram-per-foot charge, the loading density has been increased to 10 grams per foot and improvements were made to the charge configuration details. Previously it had been necessary to change the explosive ring from aluminum alloy to stainless steel to reduce variance in the performance of the charge, as well as to eliminate shrapnel at the loading density required for reliable separation. Because of manufacturing problems at Minneapolis-Honeywell, the steel rings are now being fabricated at McDonnell and will be loaded at Minneapolis-Honeywell. Ten hatch assemblies built during January 1961 are to be used in final qualification. Three assemblies are to be environmentally conditioned prior to firing. All essential features of the assembly are otherwise environmentally qualified by previous testing. The final firing tests will be scheduled as test specimens become available.

(c) Integrating accelerometer - Qualification and reliability test reports were approved in November 1960.

A study of the qualification and reliability status of PROJECT MERCURY is being kept current to identify test programs that may be critical in relation to launch schedules.

McDonnell Biweekly Quality Assurance Progress Reports are being submitted for information and review.

Airdrop Program

The helicopter airdrop program, phase II, was completed during the period November 21 to 30, 1960. Four drops were made onto water with the primary objective of proving the suitability of the MERCURY-production impact-skirt system for operational use on MERCURY capsules nos. 5 and 7 (MR-2 and MR-3). To meet this objective, it was necessary that at least one airdrop be made under the 18-knot-wind condition specified as the maximum for these missions. Secondary objectives were to investigate the capsule dynamics and water stability for a capsule in the MR-2 and MR-3 configuration. A complete tabulated summary of the four drops is given in table I.

The drop capsule was fitted with a production landing system consisting of beryllium heat sink, fiber-glass skirt with 24 steel straps and a simulated protective dome under the large pressure bulk-head. The capsules were airdropped by Marine helicopters using the same techniques as on the previous airdrop program reported in Status Report No. 8.

The objectives of the tests were achieved, and the landing-skirt system was approved for operational use under the 18-knot-wind conditions specified. Capsule flotation and righting characteristics were found to be acceptable and agree with those predicted by the capsule water-stability curves.

A future airdrop program may be necessary if modifications to the landing-skirt system are required in order to meet the 30-knot-wind conditions specified for capsule no. 9 and subsequent capsules.

Systems Tests

Scope and purpose of simulated orbital test program.- The simulated orbital test program will consist of partial- and full-duration simulated orbital missions, during which the capsule systems will be exercised in normal and emergency modes. In addition, the capsule will be used as a test bed to investigate the effects of any capsule systems changes that result from this test program and from flight-test experience. The test program will be accomplished with all possible speed, and will extend up to the time of the first MERCURY manned orbital mission.

The purpose of the test program is to demonstrate that the capsule is capable of carrying out its mission of sustaining manned orbital flight, to uncover capsule design deficiencies, if such exist, and to define any capsule design problems that may exist.

The test objectives of this program are:

(a) Establish levels of confidence in the operation of the integrated capsule systems while demonstrating the attainment of the design performance of these systems during repeated full-duration missions.

(b) Demonstrate the satisfactory performance of the integrated capsule systems under simulated emergency modes of operation. These emergency modes will be chosen to represent the most likely and most critical combinations of malfunctions that are possible to be encountered.

(c) Use the capsule as a test bed to investigate the operation and performance of any capsule systems changes and improvements that may result from flight-test experience.

(d) Investigate the effects of simulated orbital-flight cyclic heating and cooling on systems operation and on capsule structure.

(e) Verify operation of capsule sequence of operations of various subsystems involved in simulating the pressure environment of reentry.

Testing philosophy and general mission categories.- The general philosophy to be followed in the testing procedure will be as follows:

A test must be repeated until all primary systems for that test operate properly throughout a test, at which time the test will be changed to exercise a primary system in a different mode or to exercise an additional system or component or modification.

Generally, a successful test will not be repeated, due to the limited testing time and the large number of possible modes of operation of systems and components. All supporting systems must demonstrate satisfactory operation while a primary system is demonstrating satisfactory operation. Any particular capsule system will thus have to demonstrate satisfactory operation a number of times, i.e., at least once as a primary system and a number of times as a supporting or passive system.

It is expected that by continuous testing in this way, it will have been possible to run sufficient tests before manned orbital flight to have detected all those deficiencies that can be found by ground tests and to have applied corrective action where applicable.

Test missions.- The major missions of the test program are outlined below.

Category I - A full-duration orbital flight phase of "normal" orbital missions. At least one of these full-duration test missions is to be conducted with no electrical leads passing through the pressure vessel and with the astronaut's window in place. Additional full-duration test missions may be made with a special plate replacing the astronaut's window.

Category II - Test runs designed to intensify operational exercising of specific systems. (Initial test missions are planned to deal exclusively with the stabilization and control system.)

Category III - Test runs designed to introduce different emergency modes of operation, preselected systems malfunctions, and various combinations thereof.

Category IV - Tests to investigate particular system-malfunction conditions noted during Categories I, II, and III missions or during actual flight tests. These tests are to be conducted as required for the particular malfunction being investigated and are not necessarily conducted using the test capsule with a complete mission profile.

Schedules.-

Facility - All mechanical work has been completed on the test chamber. The addition of supplementary pumping systems has resulted in a present empty-chamber simulated-altitude capability of 280,000 feet. The test fixture is approximately 90-percent complete. LJ-1B capsule is on loan to McDonnell to aid in setting up the test fixture in the altitude chamber.

Capsule - The capsule is currently in Capsule Systems Tests which are about 40-percent complete. The capsule will be available for the test facility near the end of February 1961 to start preparations for the test program.

Tests - It is expected that the first simulated orbital test mission, with the capsule in the altitude chamber, will be conducted on or about March 31, 1961. Tests will continue in the environmental test facility at least until the first manned orbital flight mission.

OPERATIONS

The operations for PROJECT MERCURY include such items as provision of a ground-tracking and instrumentation network, preparation of the capsules for flight, flight control using the network, recovery of the capsules following flight, and flight safety. The following sections discuss the present status, plans, and schedules of the MERCURY flight operations.

Tracking and Ground Instrumentation System

The MERCURY range is progressing satisfactorily. Installation of electronics equipment is completed at all sites except Kano and Zanzibar. Airplane fly-by dynamic testing is in progress at Australia, Bermuda, and California. The Canary Islands site has been visited by a NASA technical inspection team and is provisionally accepted as ready. Bermuda and the Atlantic and Indian Ocean Ships are presently being inspected for acceptance. Present schedules indicate that all stations will be operational by March 1961.

The following are approximate completion percentages:

Engineering Design Studies	96 percent
Detailed Engineering	92 percent
Major Equipment Procurement	98 percent
Subsystem Manufacture and Demonstration	88 percent
Computing Utilities and Rentals	99 percent
Site Contruction	99 percent
Installation and Site Tests	73 percent
Operator Training	54 percent

Spares and Replacement Parts	52 percent
Transportation and Warehousing	90 percent

The overall project is approximately 92 percent complete.

Emphasis has been placed on the aircraft fly-by dynamic testing of the range, especially Bermuda and the Canary Islands in order that these sites may support the MA-3 mission. Bermuda and Cape Canaveral have jointly participated in simulated exercises of the MA-3 mission. These exercises will presently include the Canary Islands.

Cape Canaveral and NASA Goddard Space Flight Center participated in the successful firings of the MR-1A and MR-2. All systems except the ground-to-air system were exercised. The Goddard computers were programed for the Redstone trajectory, and data were relayed to the plotboards and digital displays at the MERCURY Control Center.

During the MR-2 operation, the Bermuda acquisition aid, radar, telemetry, and UHF voice were exercised. At the same time, telemetry and voice communications were exercised at Grand Turk and on the Atlantic Ocean ship berthed in the Jacksonville, Florida harbor.

Ground communications are active at all land stations.

Communications and data-flow integrated subsystem tests will begin the week of February 6, 1961. This will exercise the digital data lines from the remote radar stations to the Goddard computers.

Launch Operations

Capsule preparations.- Additional support, both in manpower and facilities, has been implemented at Cape Canaveral to provide for capsule operations on a three-shift basis 7 days per week. This complement makes possible the support of five capsules in checkout simultaneously. The McDonnell flight support team has been increased from 175 to 350 and the Space Task Group staff has been increased from 80 to 115. The Space Task Group increase has been primarily in instrumentation and inspection fields. A Butler-type building for the staff has been erected and will be ready for occupancy in February 1961. Capsule checkout areas are being increased in Hangar S to accommodate checkout of five capsules instead of the planned three. This area is provided by removing three checkout and two telemetry trailers from the Hangar. The trailers are now located in the Hangar compound. An additional white room, junction racks, ASCS bench check room and other checkout support equipment will be added on the Hangar floor.

Work is continuing on the Engineering Operations Building adjacent to Hangar S, and this building should be available for occupancy by March 15, 1961.

Additional ground-support equipment acquired during this period includes one partial checkout trailer and a telemetry ground station.

Plans are now being developed for an oxygen and pyrotechnic service building to be added to the Hangar S compound.

Capsules now in work are no. 6 (MA-2), no. 7 (MR-3), and no. 8 (MA-3). Capsule no. 9 (MA-4) is due to arrive at Cape Canaveral in February 1961.

The windows on the altitude chamber have been modified to reduce the hazard from implosions.

To reduce capsule time at Cape Canaveral, capsule-booster prelaunch activities have been reduced to a single mating instead of two. Pad activities now include electrical and mechanical compatibility checks, radio-frequency compatibility checks, and other preparations for launch, which are to be accomplished immediately prior to Flight-Readiness-Firing (FRF) test, for Atlas launches, or prior to simulated flight tests, for Redstone launches.

Coordination

Range documentation, including preparation of Mission Directives and Operations Requirements Documents, has been completed for MR-2 and MA-2 and is in final stages for MA-3. Documentation for MR-3 and MA-4 is in preliminary stages of preparation.

A Mission Rules document was prepared and reviewed for MR-2, establishing actions to be taken in the event of systems malfunctions during the prelaunch and postlaunch periods of the mission.

A split-count concept has been incorporated into the countdown procedures to provide a rest period for the launch operations personnel prior to the final and more critical period of the countdown activities.

The animal operations procedures for the prelaunch and launch periods were exercised during the MR-2 checkout operations and utilized during the launch.

Network coordination activities during this period have included the development of a plan between NASA and Department of Defense (DOD) for scheduling network activities. This plan, pending final review and approval, includes scheduling network activities for both checkout tests and network operations during MERCURY flights. In addition, a joint DOD, Weapons Research Establishment (WRE), and NASA group has been established to provide frequency interference control. The DOD area frequency coordinators have developed a general plan for implementing control which has been accepted in principle by NASA for use as a guideline for further development.

Data coordination procedures activated during MR-1A, governing collection, logging, and disposition of flight-test data, and postlaunch reporting were satisfactory and will be used for subsequent flights. An extension of these procedures to insure consistency in data identification and routing throughout the MERCURY network has been documented and approved for implementation as the network becomes available.

Booster and Capsule Review Boards have been established to evaluate the status of capsule and booster systems for each Redstone mission prior to flight. An Active Review Team has been established having corresponding responsibilities for each Atlas mission. In addition, Flight Safety Review and Mission Review Boards have been established to review capsule-booster systems status, control-center and network-station readiness, weather conditions, recovery-force readiness, and mission outline and objectives prior to each flight in the MERCURY program.

Flight Operations

<u>Flight-control operations</u>.- Since Status Report No. 8, the MERCURY Control Center at Cape Canaveral has been utilized to support the gradual buildup of MERCURY network systems checkout, flight-controller training, launch support, and mission flight control. The entire Control Center staff was initially exercised in November and early December 1960 for the first two incomplete MR-1 launches, and mid-December for the successful MR-1A mission, and January 31, 1961 for the successful MR-2 mission. This experience in Redstone launch operations is providing a valuable buildup of operational capability of the MERCURY Control Center for the future Atlas programs. The Space Task Group and DOD assignees to the Control Center positions include backup personnel for each position who have also participated in the simulation training exercises. The Astronauts are members of this team acting as Capsule Communicators. Operating procedures and the training of the flight controllers for the MERCURY network sites around the world are progressing; however, no training exercises at remote sites, except for Bermuda, have been conducted as yet. Procedures for flight control and station operations to support the MA-3 and MA-4 missions are being prepared.

Flight-controller training.- The flight-control groups for Cape Canaveral and Bermuda have recently obtained their first experience in a closed-loop launch simulation and in control handover procedures. This exercise was in preparation for the MA-3 mission. Many such training programs will follow, in order to exercise the Bermuda equipment and the staff, which has only recently become fully implemented.

There are 16 three-men teams of remote-site flight controllers being organized into a training program conducted at Space Task Group. In December 1960, a contract was established with the Philco Corporation to obtain experienced manpower for assignment to Space Task Group to perform the flight-controller function of Capsule Systems Monitor. This contract group is now at Space Task Group and is presently engaged in an intensive training program. The Space Task Group-assigned Capsule Communicators and DOD-assigned Medical Monitors are being trained in flight control and operating procedures by means of Space Task Group-operated Remote Site Simulator coupled with the Capsule Procedures Trainer at Langley Field. Special study material, including a Flight Controller Handbook of Capsule Systems and Operations, has been developed for this program. A handbook of network operations and flight controller procedures is currently being developed for use during preliminary network operational drills for orbital flights.

A number of important aspects of real-time flight monitoring and communications procedures were evaluated at the Wallops Island representative remote site. Emphasis was placed on site operating procedures, particularly on the interface between maintenance and operation and flight control personnel.

Control Center simulation.-

(a) Cape Canaveral - All the equipment required for the Cape Canaveral simulation exercises has been installed, including the analog computer necessary for simulation of the manned orbital missions.

To date, a complete systems test by the contractor has not been accomplished; however, the simulation equipment has been used on an interim basis by the Space Task Group. Additions to the Telemetry and Command Console, which are necessary to duplicate the telemetry outputs from the early series of capsules, are incomplete at the present time. The trajectory simulation equipment has been operated and the plotboards have been driven. However, because the program in the Goddard computer is incomplete, a complete trajectory simulation utilizing this computer has not been accomplished.

During this period, seven simulation exercises were conducted for the MR-1, MR-2, MA-2 and MA-3 missions. In general, these simulations were concerned with flight-controller training for specific missions; however, some periods were devoted to the development of procedures. For the MA-3 exercises, the network facilities included the Bermuda Control Center, and the telephone and teletype lines through Goddard.

(b) Bermuda - Bermuda simulation exercises were conducted in the latter part of this reporting period. These exercises used telemetry and trajectory data prepared on the simulation equipment at Cape Canaveral. The simulation equipment at Bermuda is generally operational with minor exceptions in the communications equipment. During the simulations, it was demonstrated that the trajectory displays could be generated by the computer complex in real-time using simulated radar data.

(c) The simulation programs or scripts, for both Cape Canaveral and Bermuda, have been developed for maximum use of alternate sources of data and for the exercise of all command functions. Alternate data sources include the second telemetry system and visual tracking reports. The command functions include Abort, Sustainer Engine Cutoff (SECO), and Retrosequence.

Recovery Operations

Recovery planning and preparations.-

(a) Contingency recovery - A Contingency Recovery Planning conference was held in Norfolk, Virginia, on January 23 to 25, 1961 to finalize an overall contingency recovery support plan for NASA Space Task Group approval. Representatives from the various DOD Support Commands involved and the NASA Space Task Group attended this conference. In general, the plan submitted met the stated requirements and was approved for implementation. A portion of the support forces for the Indian Ocean region have not yet been identified within the DOD; however, the magnitude of support to be provided was agreed upon. Contingency recovery medical requirements can be met by the operational support provided by the plan. Detailed medical guidelines are being firmed up by NASA Space Task Group and the DOD representative assistant for bioastronautics, and will be transmitted to the support agencies in the near future.

(b) Launch-site recovery - Planning has been in progress to develop a capability for emergency recovery of the astronaut on the launch pad. Present plans call for an emergency egress team to be stationed close to the blockhouse ready to go to the aid of the astronaut. The team would be transported by a fast-moving armored vehicle which could be used either to deliver the team to the gantry or "cherrypicker" in the event that the capsule is still on top of the booster, or to the capsule in the event of a landing in the pad area. It is envisioned that the vehicle and team will be under the control of the launch-site recovery commander, but that in the event of a dangerous booster situation, direction of the team will revert to a command position in the blockhouse. Procedures for procuring the armored vehicle have been initiated by Air Force Missile Test Center (AFMTC). Practice exercises for this team will be held in the near future.

(c) Medical aspects - Briefings on recovery planning have been given to all medical and veterinary personnel who have been assigned to the medical recovery operation.

Documentation has been prepared on procedures for animal couch removal for the MR-2 mission. This document was used to train teams composed of ships personnel aboard each of the recovery ships in the proper procedures for removal of the animal couch. A document covering the removal of the astronaut from the MR-3 capsule is currently being prepared.

(d) Recovery equipment - Delivery has been completed on 145 pairs of aircraft antennas and 51 Simmonds SARAH receivers. Sixty of the 90 International Telephone and Telegraph Corporation (ITT) receivers have been delivered and the rest are expected by mid-February 1961. A flight check of the Simmonds and ITT receivers in a WV-2 aircraft indicated that the production ITT receiver could be expected to have about 10 nautical miles more range than the production Simmonds receiver. The ITT receiver also has more operational flexibility.

Recovery Tests

MR-1 recovery operations.- All down-range recovery ships and aircraft were on their planned stations at the time of launch. The recovery forces were informed of satisfactory initial missile flight approximately $2\frac{1}{2}$ minutes after lift-off. At approximately T+11.5 minutes, the predicted time of main parachute deployment and recovery beacon activation, all aircraft received electronic directional-finding (D.F.) signals on recovery location receivers. At approximately T+13 minutes, the capsule was sighted at approximately 5,000 feet. The capsule landed about 16 nautical miles downrange of the nominal predicted landing point and was picked up by a helicopter approximately 14 minutes later. All recovery aids functioned as intended. Operation of all retrieval equipment was satisfactory. The action of all units was as planned, and the performance of the forces actually involved in capsule recovery was excellent.

LJ-5 recovery operations.- The recovery support for this operation consisted of a Navy salvage ship, Marine Corps HUS helicopters, and two small craft chartered by the NASA. Due to a flight malfunction which resulted in the capsule not separating from the booster, the configuration landed in about 70 feet of water 12 nautical miles offshore. Salvage operations commenced immediately and continued for 7 days. Approximately 60 percent of the booster, 40 percent of the capsule, and 80 percent of the escape system were recovered. Study of these recovered parts aided materially in establishing the probable cause of the malfunction.

MR-2 recovery operations.- The MR-2 recovery forces included a salvage ship (ARS), six destroyers, a Landing Ship Dock (LSD) with three Marine HUS helicopters embarked, three P2V aircraft, two Atlantic Missile Range (AMR) C-54 aircraft and a WV-2 aircraft (used primarily to evaluate the ITT receiver). All forces were in position and ready when the capsule was launched at 11:54 a.m. e.s.t. The WV-2 picked up the UHF voice transmissions 5 minutes after lift-off (about 140 nautical miles). This signal was lost 9 minutes after lift-off. The P2V aircraft, which were located at the planned landing point, started receiving the SARAH beacon signals as soon as the main parachute opened and the transmitter was turned on. The P2V aircraft lost the SARAH signals after 3 or 4 minutes as the capsule descended below the horizon. All aircraft proceeded downrange and the two closest P2V aircraft regained SARAH contact at 12:30 p.m. and were over the capsule at 12:38 p.m. The closest destroyer closed at maximum speed and arrived at the capsule at about the same time as one of the helicopters which had been launched from the LSD. The helicopter picked up the capsule at 2:50 p.m. e.s.t. and returned it to the LSD where the chimpanzee was removed.

Capsule water stability.- Results of water-stability tests have indicated that a capsule center-of-gravity location at Station 119.5 is the highest acceptable position from the standpoint of static stability. In order to obtain this location on the capsules assigned to the earlier Redstone missions, it has been necessary to add ballast to the inner surface of the heat shield. Tests have been completed to determine the water stability of the skirted capsule with a constant center-of-gravity location, for various heat-shield ballast conditions. Results show that ballast at the heat shield gives a slight increase in water stability for moderate capsule list angles, but has no effect at the higher list angles. Astronaut egress exercises were conducted for conditions simulating the first manned capsule (MR-3) weight, ballast, and center-of-gravity position. Egress under these conditions was reported to be acceptable, but marginal. Work is currently underway to investigate the effect of water absorbed by the capsule insulation on water stability and egress.

Location-aid tests.- The need exists for beacon-equipped drop buoys to be used by the contingency recovery forces to extend the electronic location time in situations when the capsule batteries are likely to expire before the arrival of a ship. An evaluation of two possible beacons was performed using ARA-25 receivers in P5M, P2V, and WV-2 aircraft. One beacon (Sperry Gyroscope Company, Sunnyvale Development Division output power - 4 watts) had a reliable homing range of 106 nautical miles at 10,000 feet and the other (Granger Associates output power - 4-watt peak and 2-watt average) had a reliable homing range of 100 nautical miles at 10,000 feet.

Flight Safety

Rollout inspections of MR boosters.- Operational problems made it impractical for the Flight Safety Review Board to conduct "rollout" type inspections at MSFC on the boosters for the MR-1A and MR-2 missions. An alternative procedure involving review of MSFC acceptance test reports supplemented by discussion at the AMR Booster Review meeting provided an acceptable substitute.

Flight safety reviews of MERCURY-Redstone missions at AMR.- The Flight Safety Review Board conducted review meetings to establish flight readiness of capsule no. 2 on November 1, 2, and 18, 1960 for the MR-1 mission, and on December 13, 1960 for the MR-1A mission. The flight-readiness status of the MR-1 booster was reviewed by the Board on November 1, 1960, and that of the MR-3 booster (used on MR-1A) was reviewed on December 16, 1960. Final reviews of the readiness of all elements for the MR-1 mission were held on November 5 and November 19, 1960, and for the MR-1A mission on December 17, 1960.

Review meetings for MR-2 were held on January 25, 1961 for the capsule and on January 28, 1961 for the booster and complete MR-2 mission.

Development Engineering Inspections on capsules.- A plan has been worked out for holding Development Engineering Inspections (DEI's) on a regular basis with a relatively permanent inspection team. These inspections are to be held approximately monthly and will cover whatever capsules are in an appropriate condition for examination at the time. The size of the inspection team and the scheduling of its activities will be arranged to avoid appreciable interference with work in progress on the capsules. As a followup on the DEI's, selected members of the DEI team will also participate in the simulated mission test of each capsule.

The first DEI scheduled under this new plan was held at McDonnell on January 16 and 17, 1961. Capsules examined by the inspection team at this time were no. 9 (MA-4), and no. 11 (MR-4). The Inspection Board processed 82 "Requests for Alteration" submitted by the team members. Of these 82 items, 50 were found to be mandatory prior to delivery, 11 were desirable with effectivity to be negotiated, 9 were study items, and 12 were rejected or withdrawn.

Reliability.- McDonnell Reliability Program Status Report 7007-16 dated December 31, 1960 and Failure Summary Report 7007-15 dated November 30, 1960 have been received and reviewed by the Space Task Group.

Space Task Group has completed the review of the following documents prepared by McDonnell for NASA Headquarters:

(a) Astronaut Task Description and Performance Evaluation

(b) Volume 1 - Methodology and Supporting Data

(c) Volume 2 - Overrides and Estimates

Space Task Group is continuing their assistance to the NASA Headquarters program for assessing the reliability of PROJECT MERCURY. A method has been established by Space Task Group for utilizing the IBM-704 computer in the reliability analysis.

The Space Task Group has initiated a ground test program on capsule no. 10 to determine performance, flight safety, and reliability of the integrated capsule systems. (See section entitled "Systems Tests.")

FLIGHT-TEST PROGRAM

The qualification program for proving the operation of all PROJECT MERCURY components includes a series of buildup flight tests which culminate in manned orbital flights. The following sections discuss this flight-test program in some detail. Four flights have been made with McDonnell production capsules as follows:

(a) Pad abort flight on May 9, 1960, capsule no. 1 - successful. Discussed in Status Report No. 7.

(b) Suborbital Atlas flight (MA-1) on July 29, 1960, capsule no. 4 - unsuccessful. Discussed in Status Reports Nos. 7 and 8.

(c) LJ-5 flight on November 8, 1960, capsule no. 3 - unsuccessful. Discussed in section entitled "Little Joe Flights."

(d) MR-1A flight on December 19, 1960, capsule no. 2 - successful. Discussed in section entitled "Redstone Flights."

(e) MR-2 flight on January 31, 1961, capsule no. 5 - successful. Discussed in section entitled "Redstone Flights."

Little Joe Flight

Flight test of capsule no. 3.- The MERCURY-Little Joe No. 5, using capsule no. 3, was launched at 10:18 e.s.t. on November 8, 1960 from Wallops Island, Virginia. The launch was normal until 15.4 seconds after lift-off, at which time the escape-rocket motor was prematurely ignited. The capsule remained attached to the booster until impact and was destroyed. None of the test objectives were met. As a result of a postflight investigation, the failure of the mission was attributed to one of the following causes:

(a) Failure of one of the capsule-to-adapter clamp-ring limit switches.

(b) Failure of one of the escape-tower clamp-ring limit switches.

(c) Misrigging of one of the above limit switches so that vibration or a small deflection of a striker plate could have permitted switch closure.

As a result of the failure of the LJ-5 mission, changes were made in the sequential systems of capsules nos. 2 and 6 to prevent recurrence of the probable cause of the failure. The other MERCURY capsules already had a design change which will not permit such an occurrence.

Little Joe No. 5A.- Since the test objectives were not met, a repeat of the LJ-5 mission has been scheduled, using MERCURY capsule no. 14, in a test designated LJ-5A. Capsule no. 14 has only the instrumentation, electrical sequential, and landing systems, and those components of the environmental and communications systems which are required for the mission. The booster for this flight has been erected at Wallops Island; the capsule was delivered on January 20, 1961 and is now undergoing systems tests in preparation for the flight, which is scheduled for February 27, 1961.

Flight plan and test objectives.- The flight plan and test objectives for LJ-5A are generally the same as those for LJ-5. The Little Joe booster and the MERCURY capsule will be launched at a nominal elevation angle of 82.5° to the horizontal. In the booster, two empty Castor rocket motors with dummy nozzles have been ballasted so that the maximum dynamic pressure encountered during the flight will not exceed 1,400 pounds per square foot. Two Castor rocket motors and four Recruit rocket motors will be ignited simultaneously at lift-off. At 34.5 seconds of flight, timers will initiate the abort sequence. Conditions of flight at this time will be dynamic pressure, 890 pounds per square foot; Mach number, 1.5; altitude, 33,000 feet; and range, 3 nautical miles. The escape and landing system will then operate as in a prestaging abort on an orbital MERCURY flight.

The purpose of the flight test is to qualify the capsule and escape system at a combination of dynamic pressure and Mach number that represents the most severe conditions anticipated for an abort from a MERCURY-Atlas launch trajectory. The flight will also provide a performance test of the following:

(a) Escape system

(b) Tower jettison procedure

(c) Landing and parachute systems

(d) Capsule water stability

(e) Location and recovery equipment

Redstone Flights

MR-1A flight.- The MERCURY-Redstone program attained operational status since Status Report No. 8. The first Redstone flight was made on December 19, 1960 on its third launching attempt. The launch scheduled for November 7, 1960 was scrubbed due to a helium leak in the capsule Reaction Control System relief valve, and the launch attempted on November 21, 1960 was not completed due to the Redstone booster prematurely shutting down. This shutdown was caused by premature loss of electrical ground to the booster during lift-off. This second launch attempt caused the capsule to receive a normal cutoff signal, which resulted in the escape tower being fired and the recovery sequence going into effect. The third attempt at launch was made on December 19, 1960, which was successful and resulted in a flight in which all test objectives were met. The MR-1A launch is shown in figure 2.

The MR-1A flight was unmanned. The flight was designed to partially qualify the MERCURY capsule for space flight and to qualify the flight system for a primate flight, scheduled to follow MR-1A flight. The test objectives were as follows:

(a) Qualify the capsule-booster combination for the MERCURY-Redstone mission which includes attaining a Mach number of approximately 6.0 during powered flight, a period of weightlessness of about 5 minutes, and a deceleration of around 11g on reentry

(b) Qualify the posigrade rockets

(c) Qualify the recovery system

(d) Qualify the launch, tracking, and recovery phases of operation

(e) Qualify the ASCS, including the Reaction Control System

This flight also provided information concerning the operation of the retrorockets in a space environment, operation of instrumentation and other capsule systems, including the radio command control system, operation of the electrical and sequential system, and an open-loop evaluation of the Automatic Abort-Sensing System.

This flight was essentially normal in every respect; the powered flight of the mission was normal, except for a higher than nominal cutoff velocity of about 230 feet per second. Consequently, the range, maximum altitude, and maximum acceleration during reentry were greater than normal; the range was 207 miles, the altitude was 116.6 nautical miles, and the reentry deceleration was 12.4g.

After engine cutoff, the tower-separation and capsule-separation sequences occurred at the proper times and capsule turnaround was accomplished satisfactorily. The retrofire sequence was commanded from the MERCURY Control Center as planned. This command was received in the capsule and the ASCS pitched the capsule to the retrofire attitude and retrofiring of the retrorockets was initiated. All retrorockets fired and retropack-jettison and landing-system sequences functioned normally. Other capsule systems performed well throughout the flight with few exceptions.

The capsule landed about 8 miles downrange of the estimated landing point. During descent, the capsule was sighted at an altitude of 5,000 feet by search aircraft and was picked up by helicopter 15 minutes after impact (31 minutes after launch). The recovered capsule being landed upon the deck of the aircraft carrier "VALLEY FORGE" is shown in figure 3.

MR-2 flight.- The MR-2 mission, which involved flying a primate under essentially the same conditions as in MR-1A, was flown at 11:54 a.m. e.s.t. on January 31, 1961. Capsule no. 5 was utilized for this mission. On MR-2, the launch and most of the powered flight proceeded satisfactorily; however, the propulsion control system permitted higher than planned thrust throughout the flight. The high thrust caused an early LOX depletion and an abort signal was generated at approximately 5 seconds before planned burnout. The abort sequence was initiated and operated properly. The retrorocket assembly was jettisoned as programed for a Redstone abort. An overvelocity condition of the booster coupled with the velocity produced by the escape rocket and no retrorocket retarding velocity increment resulted in the capsule flying to a higher altitude and longer range than planned. The capsule was recovered however, with the chimpanzee alive and apparently unharmed. All capsule systems apparently operated properly for the abort mode with the exception of a failure in the cabin pressure relief valve and a failure of the landing impact bag and straps during the time period between landing and recovery.

Flight plans.- At the present time, capsule no. 7 is at Cape Canaveral undergoing checkout tests after having completed Capsule Systems Tests and Simulated Flight Tests at McDonnell. No major problems have been encountered during checkout at Cape Canaveral to date. The MERCURY-Redstone booster no. 5 will be used on this mission. The MR-3 booster was used on the MR-1A flight, due to damage being received by the MR-1 booster on the November 21, 1960 launch attempt.

Coordination with NASA Marshall Space Flight Center.- Continuing coordination between Space Task Group and MSFC has continued since Status Report No. 8. No formal panel meetings have been held during this period; however, informal discussions and group meetings were accomplished during this time interval, especially during the two attempted launches and the successful launch at Cape Canaveral.

Capsule Systems Tests.- Capsule Systems Tests have continued at McDonnell on the capsules planned for the Redstone program. Capsule no. 11, to be utilized on MR-4 flight, is presently undergoing systems tests and was the subject, together with capsule no. 9, of a DEI on January 16 and 17, 1961. No major problems have been found on capsule no. 11, and it is expected that this capsule will be delivered to Cape Canaveral on schedule. MERCURY-Redstone booster no. 6 will be used on this flight.

General.- Analysis of the tracking data on MR-1A flight confirmed the existence of a "popgun" effect that was predicted by tests in the NASA Lewis Research Center altitude wind tunnel. A change in trajectory has been made for MR-2 and subsequent flights. This change was brought about by the desire of Range Safety to provide greater safety margins in the powered-flight limit boundaries. The new trajectory is flatter and changes the maximum altitude to approximately 100 nautical miles, and range to 254 nautical miles, with a reentry acceleration (which includes "popgun" effect) of 10.9g. The time of weightless flight is reduced to $4\frac{1}{2}$ minutes. Although a change in firing azimuth to 100° was contemplated, the firing azimuth of 105° still remains.

Atlas Flights

<u>MA-1 flight</u>.- The MA-1 flight-failure investigation has been completed. The results of the investigation indicate, as discussed in the section entitled "Atlas Structure," that the failure probably resulted from a combination of discontinuity stresses at Atlas Station 502 and stresses induced by Atlas and adapter buffeting.

While the above hypothesis has not been proven conclusively, the capsule and booster flight data, the adapter vibration investigation results, the capsule special wind-tunnel test results, and the results from an analytical investigation all appear to be consistent with the above hypothesis.

As a result of this investigation, two modifications have been made for the forthcoming MA-2 flight: (1) the adapter has been stiffened to minimize dynamic reactions arising from aerodynamic buffeting and (2) the front end of the booster has been strengthened near booster Station 502, where the discontinuity stresses exist and where the adapter loads are transferred into the booster structure. The MA-2 adapter, and the booster front end have been instrumented heavily with strain gages, pressure transducers (static and dynamic), vibration accelerometers, thermocouples, and displacement gages, to pinpoint the trouble if MA-2 should experience a flight failure similar to that for MA-1.

The MA-1 flight-test results have been reported in the following documents:

(a) <u>Capsule</u> - Postlaunch Report for Mercury-Atlas No. 1 (MA-1). NASA Space Task Group Project Mercury publication, Aug. 2, 1960.

(b) <u>Capsule</u> - Project Mercury Flight Test Report for Mercury-Atlas Mission No. 1 (Capsule No. 4). NASA Project Mercury Working Paper No. 159, Nov. 4, 1960.

(c) <u>Capsule</u> - Project Mercury Reconstruction Investigation of Recovered Components for Mercury-Atlas No. 1 After Mission Failure. NASA Project Mercury Working Paper No. 154, Aug. 31, 1960.

(d) <u>Booster</u> - Flight Test Evaluation Report, Missile 50D. Rep. No. AE 60-0323, (Contract AF 04(645)-4), CONVAIR-ASTRONAUTICS Sept. 12, 1960.

MA-2 flight.- The MA-2 launch is presently scheduled for late February 1961. Both the booster (Atlas 67-D) and the capsule (capsule no. 6) are at Cape Canaveral undergoing preflight preparations. Certain modifications have been made to the adapter and to the Atlas booster, and special instrumentation has been added. (See MA-1, above.)

The MA-2 mission plan is a repeat of the MA-1 mission plan. The planned reentry will result in maximum afterbody shingle temperature and near-maximum reentry gravity.

The primary documents necessary for a full understanding of the mission are listed below:

(a) Project Mercury - Mercury-Atlas MA-2 Mission Directive (Capsule No. 6). NASA Project Mercury Working Paper No. 140, rev. Jan. 27, 1961.

(b) MA-2 Mercury Operation. AFMTC Operations Requirements No. 1903, Sept. 15, 1960.

(c) MA-2 Data Acquisition and Preliminary Evaluation Plan. Prepared by NASA Space Task Group Project Mercury Data Coordination Office, Patrick Air Force Base, Florida.

(d) Mercury Capsule No. 6 Configuration Specification (Mercury-Atlas No. 2). McDonnell Aircraft Corp. Rep. No. 6603-6.

MA-3 flight.- The MA-3 launch is presently scheduled for April 1961. The capsule (no. 8) is presently undergoing preflight preparations at Cape Canaveral. The booster (Atlas No. 100-D) is expected to arrive at Cape Canaveral early in March 1961. As an item of interest, the booster allocation has been rearranged beginning with MA-3 in order to provide boosters with stronger front ends (thick skins). This thicker skin is on the forward 80 inches of the Atlas LOX tank below the interface (Station 502). The MA-2 booster does not have the thicker skin, but has a reinforcing band which serves the same purpose.) MA-3 will have the strengthened adapter and special adapter-area instrumentation described for MA-2.

The MA-3 mission plan remains unchanged. The planned trajectory will result in a normal exit to within 150 feet per second of orbital insertion, at which time the booster will be shut down and the capsule separated normally. The retrorockets will be command-fired from Bermuda within about 40 seconds after capsule separation, and the impact point will be near the Canary Islands, about 100 miles short of the African Coast. The capsule will carry a crewman simulator and a group of vibration pickups as special instrumentation.

The primary documents necessary for a full understanding of the mission are listed below:

(a) Project Mercury Mission Directive for Mercury-Atlas No. 3 (Capsule No. 8). NASA Project Mercury Working Paper No. 149, Oct. 18, 1960.

(b) MA-3 Mercury Operation. AFMTC Operations Requirements No. 1905.

(c) MA-3 Data Acquisition and Preliminary Evaluation Plan. Prepared by NASA Space Task Group Project Mercury Data Coordination Office, Patrick Air Force Base, Florida. (To be published).

(d) Mercury Capsule No. 8 Configuration Specification (Mercury-Atlas No. 3). McDonnell Aircraft Corp. Rep. No. 6603-8.

<u>MA-4 mission</u>.- The MA-4 mission has been changed to a three-orbit mission with a crewman simulator; prior to the change, MA-4 was a repeat of MA-3 but with a primate. The purpose of the mission change is to advance the program and to provide an additional orbital mission backup capability.

MA-4 will have the strengthened adapter and booster with thick-skin front end.

The MA-4 capsule (no. 9) is presently undergoing final checkouts at McDonnell and will arrive at Cape Canaveral early in February 1961, where it will undergo additional modifications to prepare it for orbital flight. The MA-4 booster is presently undergoing front-end structural modifications (replacing thin skin with thick skin) at the CONVAIR/ASTRONAUTICS plant in San Diego, California.

<u>MA-5, MA-6, MA-7, MA-8</u>.- Capsules and boosters are in various stages of manufacture and final checkout at their respective manufacturing sites.

PUBLICATIONS

The following papers relative to PROJECT MERCURY have been received during the last 3 months:

1. Johnson, Clinton T.: Investigation of the Characteristics of 6-Foot Drogue-Stabilization Ribbon Parachutes at High Altitudes and Low Supersonic Speeds. NASA TM X-448. Nov. 1960.

2. Church, James D., Pearson, Albin O., and Bernot, Peter T.: Static Longitudinal Characteristics of Several Project Mercury Launch Vehicles at Mach Numbers Between 0.4 and 6.8. NASA TM X-433, 1960.

3. Fletcher, Herman S., and Wolhart, Walter D.: Damping in Pitch and Static Stability of Supersonic Impact Nose Cones, Short Blunt Subsonic Impact Nose Cones, and Manned Reentry Capsules at Mach Numbers From 1.93 to 3.05. NASA TM X-347, Nov. 1960.

4. McGehee, John R., and Hathaway, Melvin E.: Landing Characteristics of a Reentry Capsule With A Torus-Shaped Air Bag for Load Alleviation. NASA TN D-628. Nov. 1960.

5. Brown, Steve W., and Moseley, William C., Jr.: Summary of Wind-Tunnel Investigations of the Static Longitudinal Stability Characteristics of the Production Mercury Configurations at Mach Numbers From 0.05 to 20. NASA TM X-491, 1960.

6. Spencer, Clayton M.: MERCURY-REDSTONE Thrust Unit Water Recovery. Rep. No. MTP-M-LOD-DR 60-3, NASA George C. Marshall Space Flight Center (Huntsville, Ala.), Oct. 26, 1960.

7. North, G. B.: Development and Checkout of the NASA Mercury Capsule. Paper No. 60-101, Inst. Aero. Sci., New York, N.Y. Oct. 1960.

8. Anthony, F. B., Jr.: Extended Mercury Blast Analysis: An Analytic Study of the Blast Effect on an Atlas In-Flight Explosion on the Mercury Capsule. Rep. No. ZA-7-167, Addendum No. 1 (Contract AF 04(647)-104), CONVAIR-ASTRONAUTICS, Oct. 28, 1959.

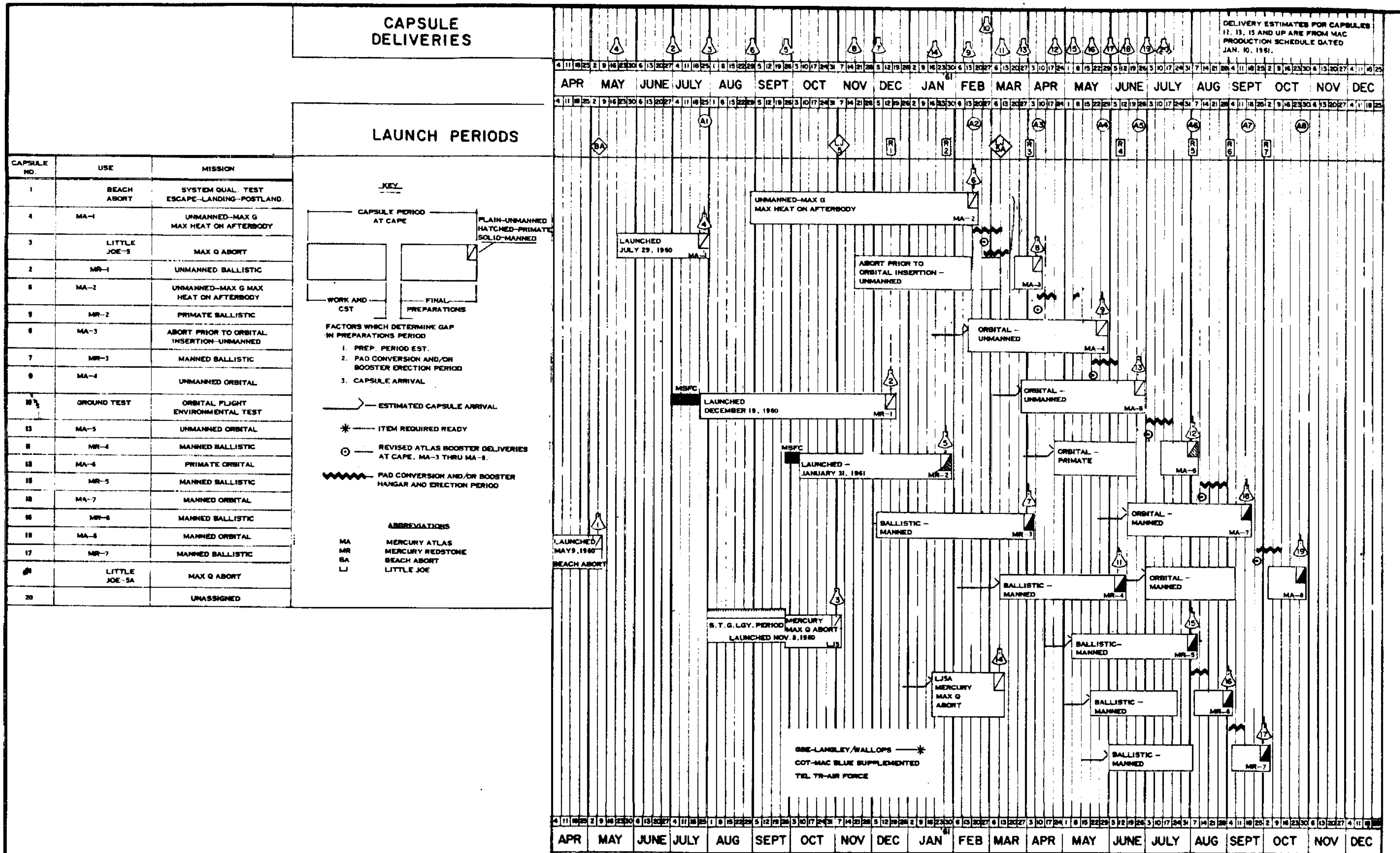

Figure 1.- PROJECT MERCURY master planning schedule status as of 2-14-61.

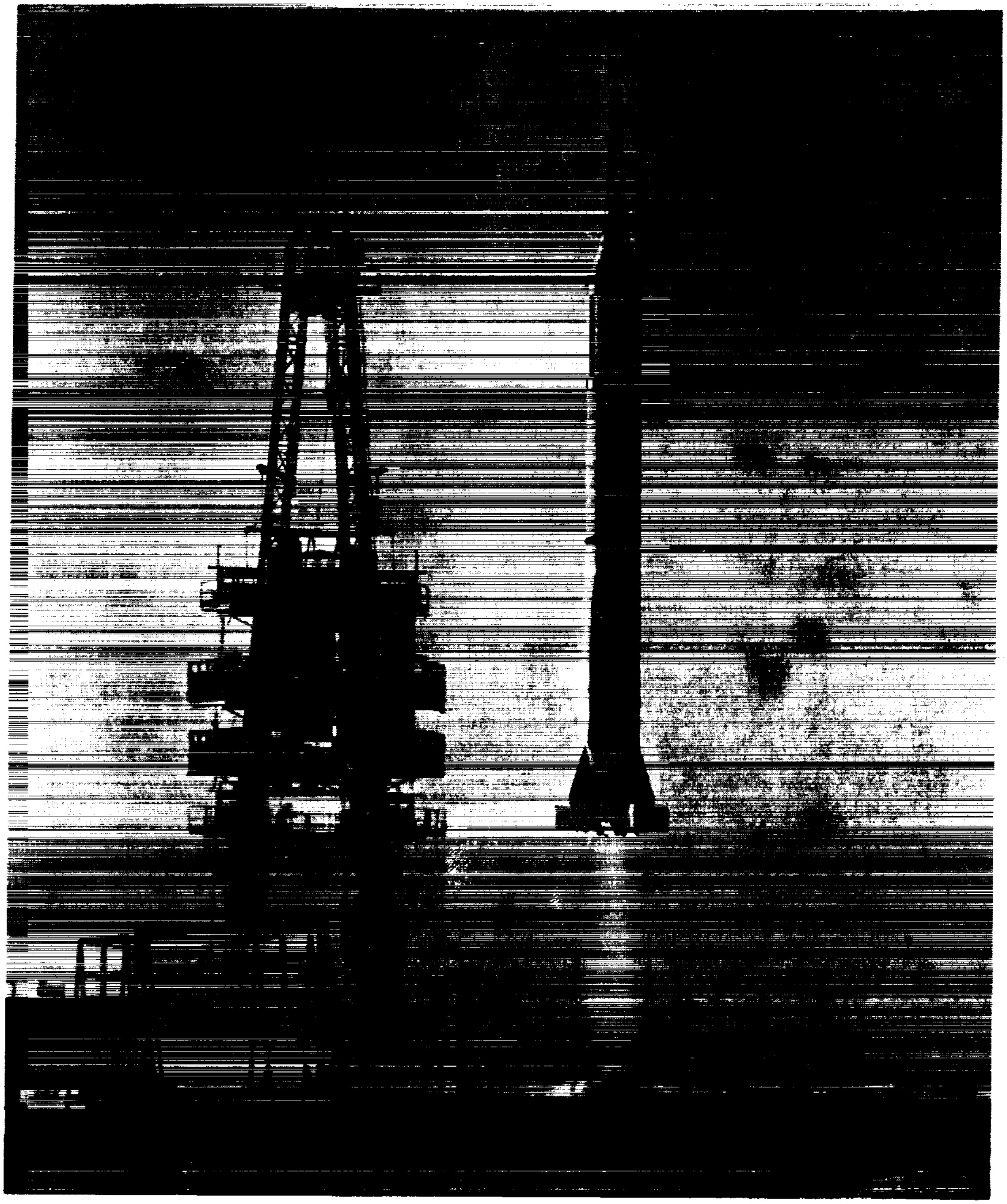

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Figure 2.- MERCURY-Redstone (MR-1A) shortly after lift-off, Cape Canaveral, Florida, December 19, 1960.

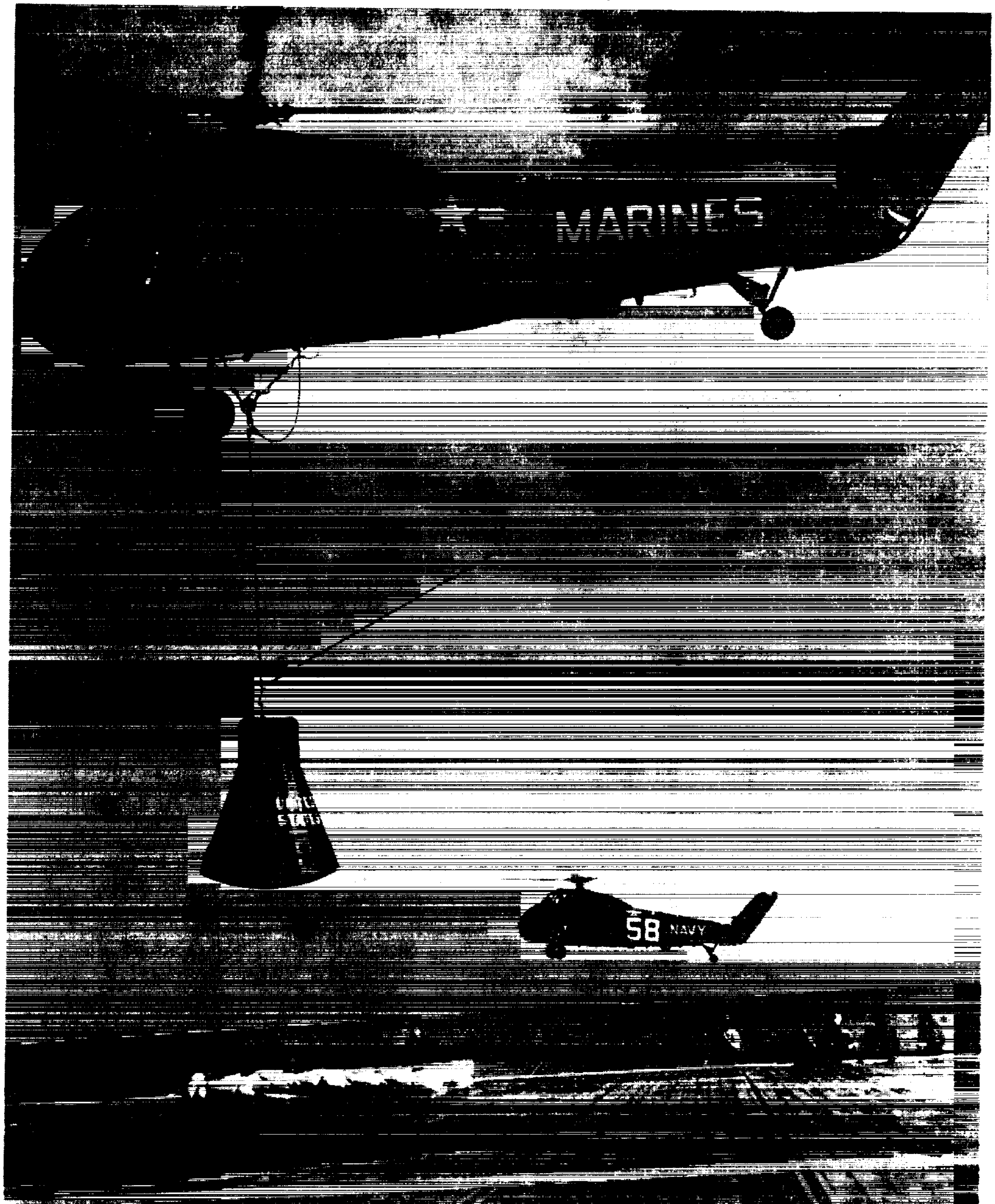

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Figure 3.- Recovered capsule from MR-1A being landed on USS VALLEY FORGE, December 19, 1960.

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TABLE I.- HELICOPTER AIRDROP PROGRAM - PHASE II

Drop no.	Landing surface	Wind condition (knots)	Parachute disconnect delay (sec)	Remarks
1	Calm sea	0 to 5	0.5	Longitudinal acceleration at c.g. = 8.25g. Max. acceleration at pilot's head = 12.0g. Righting time approx. 2 to 3 minutes. No strap failures. Small cuts in skirt due to twisting of straps on nontension side of skirt.
2	Slight sea (1-ft waves)	11	2.0	Heat sink did not deploy. Hence landing was without impact skirt. Righting time approx. 2 to 3 minutes, simulating conditions for capsule without skirt. Long. accel. = 21.4g. Max. accel. at pilot's head = 35.0g.
3	Slight sea (1-ft waves)	12 to 14	0.5	Long. accel. = 12.0g. Max. accel. at pilot's head = 16.5g. Righting time approx. 2 to 3 minutes. Four straps stretched max. stretch approx. 2 inches. No strap failures. Small cuts in skirt due to twisting of straps on nontension side of skirt.
4	Rough sea (3- to 4-ft waves)	18 to 22	0.5	Specification drop conditions. Long. accel. = 12.0g. Max. accel. at pilot's head = 15.5g. Righting time approx. 2 to 3 minutes. Four straps shared main tension loads with max. stretch of approx. 2 inches. Twisted straps on nontension side of skirt.

Capsule configuration and drop conditions for all above drops were as follows:

Capsule - Boilerplate airdrop with beryllium heat sink Wt. = 2,357 lb (with parachute)
Fiber-glass skirt and 24 straps Long. c.g. = 119.07 (heat sink up)

Drop conditions - Drop altitude = 1,000 feet
Drop speed = 45 knots (true)

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